CLAIMS

What is claimed is:

1. An apparatus, comprising:

an integrated structure having front and rear facets optically connected via a waveguide passing therethrough, the integrated structure further including:

a gain section to emit a plurality of photons in response to a first electrical input, having a facet defining the rear facet of the integrated structure;

a phase control section disposed adjacent to the gain section, to modulate an optical path length of a portion of the waveguide passing through the control section in response to a second electrical input;

a modulator section disposed adjacent to the phase control section, to modulate an optical output passing through a portion of the waveguide passing through the modulator section in response to a third electrical input, and having a facet defining the front facet of the integrated structure; and

a partially-reflective mirror disposed between the phase control section and the modulator section.

2. The apparatus of claim 1, wherein the waveguide is tilted relative to the front and rear facets of the integrated structure.

3. The apparatus of claim 1, wherein the partially-reflective mirror is oriented substantially perpendicular to a local portion of the waveguide proximate to the mirror.

4. The apparatus of claim 1, wherein the partially-reflective mirror is effectuated by an air gap defined between the phase control section and the modulator section.

5. The apparatus of claim 4, wherein the air gap is etched along a plane that is parallel to a crystalline plane structure of the integrated structure.

6. The apparatus of claim 5, wherein the waveguide is bent such that it is substantially perpendicular proximate to the air gap and angled relative to the front and rear facets of the integrated structure.

7. The apparatus of claim 4, wherein the air gap is etched along a plane that is angled relative to a crystalline plane structure of the integrated structure.

8. The apparatus of claim 4, wherein the partially-reflective mirror comprises a chirped Bragg grating formed along a portion of the waveguide between the gain section and the modulator section.

9. The apparatus of claim 1, wherein bandgaps of portions of the waveguide passing through the phase control and modulator sections are broadened approximately 0.06-0.12 eV (electron-volts) relative to a bandgap of the portion of the waveguide passing through the gain section.

10 The apparatus of claim 1, wherein portions of the waveguide passing through the phase control and modulator sections comprise an offset quantum-well structure.

11. The apparatus of claim 1, wherein portions of the waveguide passing through the phase control and modulator sections comprise a quantum-well intermixed structure.

12. The apparatus of claim 1, wherein a portion of the waveguide is configured as asymmetric twin waveguides, wherein the optical functions of amplification and phase control are integrated in separate, vertically coupled waveguides.

13. The apparatus of claim 1, wherein the integrated structure is formed from an InGaAsP (Indium-Gallium-Arsenic-Phosphorus) -based semiconductor material.

14. A tunable laser, comprising:

a base;

an integrated structure operatively coupled to the base, having a front facet and a substantially non-reflective rear facet optically coupled via a waveguide passing therethrough, the integrated structure further including:

a gain section to emit a plurality of photons in response to a first electrical input, having a facet defining the rear facet of the integrated structure;

a phase control section disposed adjacent to the gain section, to modulate an optical path length of a portion of the waveguide passing through the control section in response to a second electrical input; the phase control section having;

a partially-reflective mirror, optically coupled to the portion of the waveguide passing through the phase control section;

a reflective element, operatively coupled to the base and disposed opposite the substantially non-reflective rear facet to form an external cavity; and

a tunable filter including at least one optical element operatively coupled to the base and disposed in the external cavity.

15. The tunable laser of claim 14, wherein the waveguide is tilted relative to the rear facet of the integrated structure.

16. The tunable laser of claim 14, wherein the front facet of the integrated structure defines the partially-reflective mirror.

17. The tunable laser of claim 14, wherein the partially-reflective mirror comprises a chirped Bragg grating formed along a portion of the waveguide in a mirror section adjacent to the phase control section.

18. The tunable laser of claim 14, wherein a bandgap of a portion of the waveguide passing through the phase control section is broadened approximately 0.06-0.12 eV (electron-volts) relative to a bandgap of the portion of the waveguide passing through the gain section.

19. The tunable laser of claim 14, wherein the portion of the waveguide passing through the phase control section comprises an offset quantum-well structure.

20. The tunable laser of claim 14, wherein the portion of the waveguide passing through the phase control section comprises a quantum-well intermixed structure.

21. The tunable laser of claim 14, wherein a portion of the waveguide is configured as asymmetric twin waveguides, wherein optical functions of amplification and phase control are integrated in separate, vertically coupled waveguides.

22. The tunable laser of claim 14, further comprising a modulator optically coupled to the waveguide at the front facet of the integrated structure.

23. The tunable laser of claim 22, wherein the modulator comprises one of an electroabsorption-, Mach-Zehnder-, or directional coupler- based modulator.

24. The tunable laser of claim 23, further comprising coupling optics disposed between the modulator and the front facet of the integrated structure and configured to optically couple the modulator to the waveguide.

25. The tunable laser of claim 15, wherein the integrated structure is formed from an InGaAsP (Indium-Gallium-Arsenic-Phosphorus) -based semiconductor material.

26. A tunable external cavity diode laser (ECDL), comprising:

a base;

an integrated structure operatively coupled to the base, having a front facet and a substantially non-reflective rear facet optically coupled via a waveguide passing therethrough, the integrated structure further including:

a gain section to emit a plurality of photons in response to a first electrical input, having a facet defining the rear facet of the integrated structure;

a phase control section disposed adjacent to the gain section, to modulate an optical path length of a portion of the waveguide passing through the control section in response to a second electrical input;

a modulator section disposed adjacent to the phase control section, to modulate an optical output passing through a portion of the waveguide passing through the modulator section in response to a third electrical input, having a facet defining the front facet of the integrated structure; and

a partially-reflective mirror disposed between the phase control section and the modulator section.

a reflective element, operatively coupled to the base and disposed opposite the substantially non-reflective rear facet to form an external cavity; and

a tunable filter including at least one optical element operatively coupled to the base and disposed in the external cavity.

27. The tunable ECDL of claim 26, further comprising a cooling element thermally coupled to the integrated structure.

28. The tunable ECDL of claim 26, wherein the partially-reflective mirror is effectuated by a gap formed between the phase control section and the modulator section.

29. The tunable ECDL of claim 26, wherein the partially-reflective mirror comprises a chirped Bragg grating formed along a portion of the waveguide between the gain section and the modulator section.

30. The tunable ECDL of claim 26, wherein bandgaps of portions of the waveguide passing through the phase control and modulator sections are broadened approximately 0.06-0.12 eV (electron-volts) relative to a bandgap of the portion of the waveguide passing through the gain section.

31. The tunable ECDL of claim 26, further comprising a controller to supply control inputs to the gain section, phase control section, and the tunable filter.

32. The tunable ECDL of claim 31, wherein the tunable filter comprises first and second tunable filters.

33. The tunable ECDL of claim 32, wherein each of the first and second tunable filters comprises thermally-tunable etalons, and the controller provides inputs to control the temperature of each thermally-tunable etalon.

34. The tunable ECDL of claim 26, wherein the tunable filter comprises a Vernier tuning mechanism including respective first and second optical filters having respective sets of transmission peaks having slightly different free spectral ranges and similar finesses, and wherein tuning is performed by shifting the set of transmission peaks of the second optical filter relative to the set of transmission peaks of first optical filter to align a single transmission peak of each of the first and second sets of transmission peaks.

35. A telecommunication switch comprising:

a plurality of fiber line cards, each including,

a multi-stage multiplexer/demultiplexer;

a circulator bank, comprising a plurality of circulators operatively coupled to the multi-stage multiplexer/demultiplexer;

a receiver bank, comprising a plurality of receivers operatively coupled to respective circulators; and

a transmitter bank, comprising a plurality of transmitters operatively coupled to respective circulators, each transmitter comprising at tunable external cavity diode laser (ECDL), including:

a base;

an integrated structure operatively coupled to the base, having a front facet and a substantially non-reflective rear facet optically coupled via a waveguide passing therethrough, the integrated structure further including:

a gain section to emit a plurality of photons in response to a first electrical input, having a facet defining the rear facet of the integrated structure;

a phase control section disposed adjacent to the gain section, to modulate an optical path length of a portion of the waveguide passing through the control section in response to a second electrical input;

a modulator section disposed adjacent to the phase control section, to modulate an optical output passing through a portion of the waveguide passing through the modulator section in response to a third electrical input, having a facet defining the front facet of the integrated structure; and

a partially-reflective mirror disposed between the phase control section and the modulator section.

a reflective element, operatively coupled to the base and disposed opposite the substantially non-reflective rear facet to form an external cavity; and

a tunable filter including at least one optical element operatively coupled to the base and disposed in the external cavity.

36. The telecommunications switch of claim 35, wherein at least one ECDL employs a Vernier tuning mechanism including respective first and second optical filters having respective sets of transmission peaks having slightly different free spectral ranges and similar finesses, and wherein tuning is performed by shifting the set of transmission peaks of the second optical filter relative to the set of transmission peaks of first optical filter to align a single transmission peak of each of the first and second sets of transmission peaks.

37. The telecommunications switch of claim 36, wherein the first and second optical filters comprise respective thermally-tunable etalons.